CARNIVOROUS PLANT NEWSLETTER

Journal of the International Carnivorous Plant Society

Volume 37, No. 3 September 2008

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Journal of the International Carnivorous Plant Society
www.carnivorousplants.org

Volume 37, Number 3
September 2008

Front Cover: *Utricularia* 'Jitka'. Article on page 68. Photograph by Travis Wyman.

Back Cover: Leaf and developing flower of *Pinguicula lithophytica*. Note the glandular hairs on the underside of the leaf. Article on page 90. Photograph by Paul Temple.

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Date of effective publication of the June 2008 issue of Carnivorous Plant Newsletter: 29 May 2008.

The ICPS is the International Cultivar Registration Authority (ICRA) for cultivated carnivorous plants according to The International Code For The Nomenclature of Cultivated Plants. Send relevant correspondence to the ICPS, Inc.

PUBLISHER: ICPS, Inc., Pinole, California. Published quarterly with one volume annually. Graphic Production: Suzanne Hedderly, 1500 West Laburnum Avenue, Richmond, VA. Printer: Kandid Litho. Logo and masthead art: Paul Milauskas. Dues: $25.00 annually. ISSN #0190-9215.

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John Brittnacher, Manager • john@carnivorousplants.org

On Growing *Utricularia* sect. *Orchidioides*

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Keywords: cultivation: *Utricularia*, *Orchidioides*.

Introduction

The species in the genus *Utricularia* are grouped into many sections. The species in the section *Orchidioides* are very popular and sought after by growers because of their large orchid-like flowers, their (usually) large leaves that dwarf those of most other species, and their interesting habit of producing tubers. This section includes the species: *U. alpina*, *U. asplundii*, *U. jamesoniana*, *U. endresii*, *U. praetermissa*, *U. quelchii*, *U. campbelliana*, *U. unifolia*, and *U. buntingiana*. However, section *Orchidioides* species often carry such a stigma of being so difficult to grow and requiring such complicated techniques or challenging conditions that, despite the interest in the group, only *U. alpina* is commonly found in collections. In truth, anyone who is able to successfully grow highland *Nepenthes* or *Heliamphora* should be able to grow a number of the species in this section with little difficulty. In this article I will detail how I have grown and currently grow the species from this section in the hopes that my experiences will help to demystify these plants.

Growers and carnivorous plant articles often clump the species in section *Orchidioides* together with those in section *Iperua*, but they have different cultivation requirements. I currently grow various clones of all the section *Orchidioides* except the final two species listed above. I also grow the hybrids *U. quelchii* × *praetermissa* 'Jitka', *U. alpina* × *endresii* and *U. humboldtii* × *quelchii* (see Figures 1-2, Front Cover).

Pots

These plants must be grown in drained pots, as they require excellent drainage. Orchid baskets and water lily-style net pots are an excellent choice as they provide extra air circulation through the growing medium, but standard style pots work fine as well. My current set up is a Slack-potting (nested pot) method that seems to work well for all species, though one of my clones of *U. endresii* is behaving as if it might prefer somewhat different treatment. My Slack-potting uses a half-height net orchid basket nested in a standard pot. In time the plants will grow to fill almost any pot so any size will work. The smallest pot I recommend is 7-10cm. I have found that room for lateral spread is more important than depth for these plants, which is why I use half-height pots. Some people have mentioned to me that they believe these plant need to reach a critical size before they can flower. Usually, these growers say the plant must be large enough to fill a pot about 15cm in size. Personally, I have never found this to be true and have had plants bloom in 7cm pots.

Media

Often, the plants in section *Orchidioides* are mistakenly referred to as the "epiphytic" *Utricularia*. In truth the term "epiphyte" is inaccurate because most of the species from this section more often grow as terrestrials in habitat than on the relatively dry surface of trees, where the risk of desiccation is higher. That said, many of these plants do perform better when grown under conditions of lower moisture, which are most easily achieved by growing in a manner

Figure 1: *Utricularia asplundii*.

Figure 2: *Utricularia praetermissa*.

Figure 3: *Utricularia asplundii*, showing the coarse planting medium.

Figure 4: Left to right, *Utricularia quelchii*, *U.* 'Jitka', and *U. praetermissa* in cultivation.

appropriate for epiphytes. In my years of growing these plants my choice of medium has evolved to best accomplish this. Here I will detail that evolution and discuss the pros and cons of each stop along the way. Please note that the only species I grew when I started was *U. alpina*, which is certainly the most forgiving of the species. *Utricularia alpina* is a perfect benchmark because if you cannot get it to grow well then the odds are against your being able to grow any of the other species. Because of this I recommend *U. alpina* as a starter plant to anyone interested in beginning to grow the plants from this group. *Utricularia alpina* is common in cultivation, as *Orchidioides* species go, so it is easy to replace in the event of a loss.

My initial medium for this group was the one that is described in *The Savage Garden* (D'Amato 1998). I found that while this medium initially had acceptable drainage it would compact quickly and rapidly develop a sulfuric stench indicative of anaerobic bacterial growth. The compaction of this medium was a serious problem as compact media do not drain well and these plants are very picky about being kept too wet for long periods. Anecdotal evidence also suggests that the proliferation of anaerobic bacteria in the lower portions of the medium may also be detrimental. I suspect that this is due to the byproducts of their metabolism (i.e. hydrogen sulfide), which may be toxic although it is also possible that the anoxic conditions formed around the roots may be the cause. For these reasons I scrapped this medium and moved on.

I next tried my standard *Nepenthes* medium, basically a mix of orchid bark, long-fiber sphagnum, and small portions of perlite and fine grade horticultural charcoal. This mix drained more freely than the previous mix but I still found that it would compact over time as the sphagnum decomposed and the perlite and charcoal settled to the bottom of the pot. This eventually led to conditions detrimental to the plant. It was while I was using this medium that I acquired *U. asplundii*. My attempt to grow this plant in the *Nepenthes* medium resulted in my almost losing the plant and prompted the next stage in the evolution of my planting medium.

My third medium was a mix of 2 parts long-fiber sphagnum to one part fine orchid bark. Both *U. alpina* and *U. asplundii* grew well in this mix, which drained freely and never developed anaerobic conditions. However, in time the sphagnum would degrade leaving nothing but the orchid bark, which was not as amicable to further growth. During this time I acquired *U. praetermissa*, *U. endresii*, *U.* 'Jitka' and *U. quelchii*. These plants were given to me by a grower who used a 2:1 perlite:long-fiber sphagnum mix and after talking with him further about the medium I again made a medium switch.

The perlite:long-fiber sphagnum medium worked well for a long period. The medium drains well while holding a good supply of water. However, given the details of my watering and growing techniques this method still resulted in too much moisture, compaction of the long-fiber sphagnum, and the eventual formation of anaerobic conditions. For these reasons I chose to switch media again. However, I believe that this medium (as well as the next media I will discuss), would work fine if the plants were grown in hanging orchid baskets supplied by overhead watering/misting.

During this time I read references to cypress mulch and its alleged anti-microbial properties. I thought that this might help solve the problem of anaerobic bacterial conditions that formed in the media but I was hesitant to incorporate a totally new, unknown factor into my media. However, I had previous experience with pine bark mulch (the brand I use is Nature's Helper® Soil Conditioner but any brand should work fine) and on a whim I decided to try it and see. I washed the pine bark mulch until all the fines (tiny particles) had been rinsed away. I used washed pine bark mulch to fill half the pot and then filled the remainder of the pot with an equal part mix of perlite, pine bark chips and long-fiber sphagnum, finally I topped that with a few sprigs of live sphagnum. This combination proved very successful for most of the species, the exceptions being *U. endresii* and, I learned later, *U. quelchii*. All the plants (except *U. endresii*) grew strongly in these media and I was able to divide each annually.

It was during my most recent annual division process that I noticed something that led me to my current (but, for some reason I doubt final) method. What I noticed was that, while all the species had extremely dense stolon growth, only *U. alpina* had put stolons down deeper than a centimeter or so. Any adventurous stolon growth from species other than *U. alpina* was strictly

horizontal, involving stolons growing out and over the edge of the pot. I also noticed that the stolons of all species were most dense in the patches of live sphagnum.

In the past I had often heard of other growers using long-fiber New Zealand or Chilean sphagnum. In fact when I was first looking into growing section *Orchidioides* species these were the media most often recommended. I had no success with these media (the first *U. alpina* I attempted to grow, I placed in this kind of sphagnum and lost it before it even recovered from shipping shock) so I had written off straight sphagnum of any form from the very beginning. The dense growth around the live sphagnum made me rethink this idea.

Obviously there is a difference between long-fiber dead sphagnum and live sphagnum. In my experience, no matter what measures are taken, long-fiber sphagnum will always compact over time while live sphagnum tends to remain loose and non-compact. This somewhat minor-seeming difference in character makes for a major difference in terms of use as a medium. My current medium is live sphagnum. I grow my plants using a rather complicated Slack-potting method. Setting up the system entails putting a half-height net orchid basket in a standard pot and threading some strands of sphagnum out the bottom of the basket, to hang down into the bottom of the outer pot (see Figures 3, 4). To pot the plant I fill the half-height net pot with live sphagnum and settle the plant among the sphagnum, usually by teasing the moss over the stolons. This may seem an extravagant method but it is what works for me. I am reasonably sure that a pot filled half way with something well draining (perlite, pumice, coarse orchid bark) and topped with live sphagnum would work just fine. Using live sphagnum in this manner results in a microenviron that has the perfect balance of moisture and aeration (see Figure 5). The only plant I do not grow in live sphagnum is *U. jamesoniana*, which I grow in either straight pine bark mulch (which is not washed, so that it retains the fines) or peat:sand either in my Slack-potting style or in standard pots. From reports I also suspect that *U. campbelliana* might grow well in these same media but I do not yet have first hand experience with this species.

Watering and Humidity

These plants are best treated along lines similar to *Nepenthes*, i.e. watering to keep the media damp but not soaking wet. However, these plants have no set watering requirements and often what works well for one may not apply to others. I find that *U. alpina* is the most tolerant of excess moisture, and often grows well under conditions that would cause the loss of other plants from section *Orchidioides*. Likewise, *U. jamesoniana* is more tolerant of wet conditions and can even be grown on the tray system along the lines of a terrestrial *Utricularia*. With my Slack-potting method I simply place the whole set-up on the tray system with water 1-2cm deep and then top water whenever the tray dries. Plants grown in hanging baskets or the like can simply be top-watered frequently enough to keep the sphagnum happy and growing.

Figure 5: *Utricularia asplundii* in a nested pot.

If using any of the other potting methods/media the watering method I found that worked well was to use small Styrofoam blocks (2-3cm tall) under the pots. By setting the pot on blocks the excess water drains away so that the pot is not sitting in it but its presence in the tray creates a higher local

humidity in the range of 50-90%, most often about 70%. The pots are kept on this modified tray system and are top-watered when the long-fiber sphagnum starts to get a little dry. Using this method I will occasionally observe stolons growing out the bottom of pots and into the tray. While this might seem to contradict my statement that these plants prefer drier conditions I will note that these stolons never develop leaves and tend not to travel much more than a few centimeters from the point where they exited the pot. In time they rot away.

These plants can be conditioned to somewhat lower humidity levels, like those of a windowsill, but this should be done slowly as the leaves of many are thin and can dry out rapidly.

Light and Temperature

Previously I grew all of these species under four 120cm fluorescent tubes. To provide a broad spectrum I used 2 Sunshine bulbs, 1 warm white bulb, and 1 cool white bulb. The lights were hung so that they were 30-45cm above the pots. The few plants that I have grown outdoors I place in areas that receive dappled sunlight throughout the day; I do not allow the plants to receive full direct sun.

I have recently switched to a 400W MH/HID system on a track. Initially I had situated the plants about 90cm below the light but after observing their growth I have changed this distance to 65cm.

While these species are native to South and Central America most occur in highland areas and grow best under intermediate/highland tropical conditions. In my collection they do best when grown under the cooler conditions of my high elevation growing area located in my crawlspace. Day temperatures tend to be between 18-23°C (64-73°F), with night temperatures dropping down to 15°C (59°F) during the summer months. Winter temperatures are about 5-7°C (9-13°F) degrees lower. I have successfully adapted a clone of *U. alpina* to outdoor conditions here in Atlanta from spring through fall so it is possible to grow some of these plants under warmer conditions. Discussions with other growers have led me to believe that some of these species may be able to handle temperatures up to approximately 38°C (100°F) but only for very short periods, and the humidity must be very high during such times. Extended periods at temperatures above 33°C (91°F) often lead to the plant dropping their leaves and dying back. In some species this can lead to the death of the plant although some, such as *U. alpina* (and purportedly *U. endresii*), may come back from their tubers once temperatures drop to a reasonable level.

There are also some species that have ranges down to sea level. If you have a clone that is known to be from such a locale it might survive well under higher temperature conditions but I would not recommend experimenting on an unknown clone unless you have a duplicate specimen.

Dormancy

In my experience almost all of the forms of the *Orchidioides* species I grow exhibit some form of seasonal slowing or cessation of growth. I call this a pseudo-dormancy because the plants are not actually in a dormant state. Instead they are usually still actively growing stolons underground, and have only ceased or drastically slowed their above-ground leaf production. During this the medium should be kept only damp and it is better to err on the side of too dry than too wet. Humidity during pseudo-dormancy should be high enough to prevent desiccation of the stolons and tubers. *Utricularia endresii* is reported to have a true dormancy period where it sheds all of its leaves and dies back to the tubers and stolons, during which the plant should be kept on the dry side (Belanger 1995). For the first time this past winter I observed one of my *U. endresii* clones lose its foliage this way (I have 3 different clones). I raised the nested pot out of the water, placed it on an inverted pot, and let it dry completely for about three months. Then I lowered it back into the water and within a week I saw new growth. More recently I have noticed a die-back of foliage on one of my *U. praetermissa* clones that looks very similar to what the *U. endresii* did. I have raised this pot out of the water and will see what it does over time.

Propagation

These plants are propagated most easily via division. A clump is best taken from the mother plant during active growth and potted up in new media. While it is possible to make a successful division from nothing more than a single tuber I find that the best minimum to take is a complete peduncle base with a full tuber cluster and at least one leaf. Ensure you keep the humidity high and the media only moist for the division and the parent plant. This procedure may result in the division (and in some cases the parent) losing many or all of its leaves. Continue to treat the pot as if the plant were in pseudo-dormancy (i.e. drier than if it were in active growth) because in many cases the plant is simply establishing its stolon system first.

Seed can also be used but it must be very fresh or it will likely not be viable. My best results have been with seed less than one month old though I have had germination, at decreasing rates, on seed up to six months old if it was stored in a refrigerator. Seed older than six months is almost worthless. Sow seed on finely milled sphagnum or a peat:sand medium and keep it moist and in high humidity. A very successful method that I employ is to sow the seed on the surface of the medium in a 5cm pot, lightly water it, and then place it immediately in a sealed plastic bag. The closed bag maintains high humidity and the small amount of water that drains through the pot and pools in the bottom of the bag acts as a permanent reservoir but does not make for an excessively wet condition. After 1-2 years the seedlings can be thinned out or transplanted.

Cross-pollination of different clones is recommended to achieve vigorous seedlings, and it appears that some plants may be self-infertile. Hybridization with some epiphytic species is possible (if you like that sort of thing), and can result in attractive and relatively easily grown plants such as the cultivar *Utricularia* 'Jitka' (Studnicka 2005, 2006). Hybridization experiments can also yield results of interesting scientific value, such as the recent discovery that *U. quelchii* from section *Orchidioides* can successfully hybridize with *U. humboldtii* from section *Iperua* (Studnicka 2006). A similar hybrid was made even earlier, when *U. humboldtii* was successfully crossed with *U. alpina* (T. Carow, pers. comm.). These observations made in cultivation preceded recent high-tech results (Müller & Borsch 2005) that indicate the two sections should be merged!

References

Belanger, C. 1995. *Utricularia asplundii* and *Utricularia endresii*. Carniv. Pl. Newslett. 24: 92-94.

D'Amato, P. 1998. The Savage Garden: cultivating carnivorous plants. Ten Speed Press, Berkeley, California, 314p.

Müller, K., and Borsch, T. 2005. Phylogenetics of *Utricularia* (Lentibulariaceae) and molecular evolution of the *trn*K intron in a lineage with high substitutional rates. Plant Syst. Evol. 250: 39-67.

Studnicka, M. 2006. Unexpected hybrids of spectacular bladderwort species. Carniv. Pl. Newslett. 35: 59-61.

Studnicka, M. 2005. New cultivar: *Utricularia* 'Jitka'. Carniv. Pl. Newslett. 34: 27-28.

Taxonomic Relationships of Some *Sarracenia* spp. (Sarraceniaceae) are not Deducible based on Palynology

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Keywords: taxonomy: pollen, *Sarracenia*.

Abstract

Pollen morphometrics for *Sarracenia alata*, *S. flava*, *S. minor*, *S. purpurea* and *S. rubra* were determined in an effort to utilize polar and equatorial dimensions to help determine species relationships. Although *Sarracenia flava* was found to be distinct from the other species, which in themselves form a distinct group, this study found that pollen morphometrics do not allow greater distinction between species. Therefore, pollen measurements are not valid in determining phylogenetic relationships for the genus.

Introduction

Phylogenetic relationships of the carnivorous plant family Sarraceniaceae have been examined based upon floral morphology and embryology (DeBuhr 1975), palynology (Thanikaimoni & Vasanthy 1972), and more recently upon nuclear ribosomal DNA (Bayer *et al.* 1996). A sister group relationship of *Roridula* and Sarraceniaceae is supported by both morphological data (Conran & Dowd 1993) as well as genetic analysis (Bayer *et al.* 1996; Chase *et al.* 1993).

Within the family Sarraceniaceae, the genus *Sarracenia* comprises approximately eight recognized species (*S. alata*, *S. flava*, *S. leucophylla*, *S. minor*, *S. oreophila*, *S. psittacina*, *S. purpurea*, *S. rubra*) and two to three subspecies (*S. purpurea* subsp. *venosa* var. *burkii*=*S. rosea*, *S. rubra* subsp. *alabamensis*, *S. rubra* subsp. *jonesii*) considered by some to deserve species ranking. The extent to which the species are able to hybridize creates problems in the taxonomy at the species level. Because all the species can hybridize with each other and produce fertile offspring, taxonomists are unable to use degrees of infertility as a means for indicating degrees of relationship. Adding more complexity to the resolution of taxonomic relationships, different species clades are constructed depending upon whether plastid DNA (Freudenstein & Case 2002) or nuclear DNA (ISSR, i.e., inter-simple sequence repeat, amplification reactions) is utilized (Freudenstein *et al.* 2004). Interspecific hybridization, particularly introgression (Bayer *et al.* 1996), small population sizes prone to inbreeding and genetic drift (Wang *et al.* 2004), and a relatively genetically depauperate genus due to discontinuous distributions (Godt & Hamrick 1996) have all been postulated as explanations for the difficulty in deducing species relationships based upon DNA evidence.

Reliance upon plant life history, specifically seed traits, suggests characters such as germination and seed size are related more to geography than to phylogeny, although intraspecific groupings of populations of *S. purpurea* based on isozyme analysis (Godt & Hamrick 1996) are supported by germination studies (Ellison 2001). Morphology of leaves and flowers, the principal basis for current taxonomy, is also disputed as the best means for species identification and taxonomic relationships (Case & Case 1976; McDaniel 1971; Schnell & Krider 1976; Sheridan 1991).

Even though relied upon as the current means for species identification and taxonomy, the morphology of pitcher plant leaves and flowers has resulted in differing perspectives as to specific and infraspecific delineations and classifications within the genus (Case & Case 1976; McDaniel 1971; Schnell & Krider 1976; Sheridan 1991). For example, *S. rubra* subsp. *jonesii* has been variously classified as a distinct species or as a form or regional variant of *S. rubra*, attesting to the variability of leaf and flower morphology.

Established early in meiosis, species-specific pollen wall patterns can be used for taxonomic classification (Edlund *et al.* 2004). Pollen development in *Sarracenia* was studied as early as 1908 (Nichols 1908). Thanikaimoni & Vasanthy (1972) utilized palynology to distinguish between the genera in Sarraceniaceae and formulate a tentative phylogeny with other families but no attempt was made to identify species relationships within the family. It has been recognized that female reproductive tissues such as the stigma are able to discriminate between pollen grains, recognizing pollen from the same species while rejecting pollen from unrelated species (or from the same plant in self-incompatible species) (Edlund *et al.* 2004). Because of this, the present study was undertaken in the hope that morphometrics (the extraction of measurements from shapes) of pollen, can be utilized to help ascertain species relationships within the genus *Sarracenia*.

Materials and Methods

Mature pollen was collected from blooming plants maintained in one of the author's bog garden (MSB). Plants originated from either pure stands collected under permit (*S. alata* in LA, *S. minor* in GA, and *S. purpurea* in NJ) or from a commercial nursery specializing in carnivorous plants (Lee's Botanical Gardens, LaBelle, FL, *S. flava*, *S. rubra*). Clean tooth picks were used to scrape pollen from the umbraculum of flowers that had been enclosed by fine mesh bags to prevent entry by insect pollinators. Pollen was then transferred onto a thin film of silicon grease smeared on a glass slide. Pollen slides were flooded with Calberla stain (5.0 ml glycerol, 10 ml 95% ethanol, 15 ml distilled water, 2 drops of saturated, aqueous solution of basic fuchsin) followed by application of a cover slip prior to microscopic examination. This stain rehydrates pollen grains and reacts with sporopollenin to turn grains red for easier viewing under the microscope. Pollen was visualized using an Olympus BX60 fluorescent microscope equipped for differential interference contrast (DIC) microscopy. Images were captured with The Spot™ Advanced CCD (Diagnostic Instruments, Inc, Sterling Heights, MI) and processed using The Spot Advanced (Version 4.0.2.0) software calibrated to the objective lenses. Pollen was measured in polar and equatorial surface view and data then analyzed by ANOVA (SPSS, SPSS, Inc., Chicago, IL).

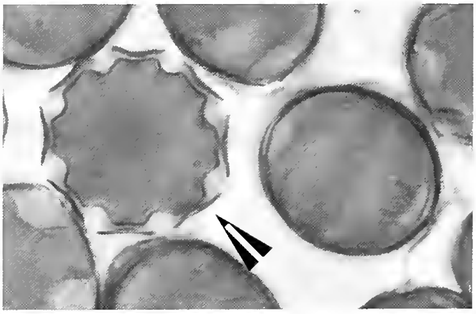

Figure 1: Representative photomicrograph of the pollen of *Sarracenia alata* following treatment with Calberla stain (100x). The arrow head depicts a pollen grain in polar view while the grain to its right is aligned in equatorial view.

Results

Pollen morphometrics based on polar and equatorial views (see Figure 1) of the species of *Sarracenia* studied are presented in Table 1 along with comparison data on size ranges reported previously (Thanikaimoni & Vasanthy 1972). Species examined include *S. alata*, *S. flava*, *S. minor*, *S. purpurea* and *S. rubra*. Based on morphometrics, *S. flava* is shown to be distinct from the other species which form a separate group. Normality and independence were verified prior to statistical analysis. Histo-gram and box-plots show the

dependent variables to be roughly normally distributed in all groups. Independence is verified in the methodology and is not a concern for this type of research. A possible problem arises with the homogeneity of variances assumption due to the fact that the sample sizes are distinctly unequal for both the polar and equatorial measurement dependent variables. A Levene's test for equality of variances indicated no reason to believe this statistical analysis suffered from a violation of this assumption (see Table 2).

Post hoc analysis of power (sensitivity) indicated that the power of the ANOVA tests to pick up true differences between means was 80% for equatorial measurements and 99% for polar measurements.

Discussion

The pollen morphology of the *Sarracenia* species examined is 6-9 colporate in agreement with Thanikaimoni & Vasanthy (1972). Polar and equatorial measurements in this study are all within the range previously reported by them following acetolysis treatment of the pollen (Thanikaimoni & Vasanthy 1972). Pollen treated with Wodehouse solution tends to be smaller than pollen treated by acetolysis and our data, for polar measurements, supports this observation. In equatorial view, the measurements obtained in this study fall within the Thanikaimoni & Vasanthy (1972) ranges for Wodehouse solution-treated pollen. Acetolysis treatment usually damages the aperture membrane but the structure of the exine at the non-apertural region appears clear. Wodehouse solution preserves the aperture membrane, symmetry and shape of the pollen grain. The exine appears superficially similar in all species examined and was not utilized in an attempt to determine species relationships.

Violations of the normality assumption in ANOVA do not adversely affect the actual level of significance observed. All the samples are roughly normal and the samples were large enough to ensure accurate determination of significance. Due to the unequal group sizes in this study, the Levene's test was utilized to verify the homogeneity of variances assumption because of its robustness and lack of sensitivity to non-normality of the sample data. The data sets met all the requirements for using ANOVA.

	S. alata	*S. flava*	*S. minor*	*S. purpurea*	*S. rubra*
Polar (mean ± s.d.)	$23.59^{a} \pm 0.72$ (n=27)	$25.68^{b} \pm 1.12$ (n=31)	$23.40^{a} \pm 1.02$ (n=18)	$23.51^{a} \pm 1.22$ (n=38)	$24.08^{a} \pm 0.95$ (n=19)
Polar (range)	22.6-25.7	23.6-29.1	22.3-26.4	21.4-26.5	23.4-27.3
Equatorial (mean ± s.d.)	$18.46^{a} \pm 0.60$ (n=18)	$18.98^{b} \pm 0.76$ (n=14)	$18.98^{a} \pm 0.99$ (n=15)	$18.43^{a} \pm 0.76$ (n=19)	$18.43^{a} \pm 0.76$ (n=19)
Equatorial (range)	18.2-20.4	18.0-21.0	18.2-21.2	17.5-20.2	17.6-20.5
Polar[c] (range)	16-20	13-24	16-22	16-19	17-22
Equatorial[c] (range)	17-23	15-23	14-20	19-22	13-21
Polar[d] (range)	19-27	20-27	16-24	18-27	18-25
Equatorial[d] (range)	15-26	15-25	14-21	16-29	16-24

[a,b] Means with the same superscript "a" are not significantly different based upon ANOVA.
[c] Results as reported in Thanikaimoni & Vasanthy (1972) using Wodehouse staining method.
[d] Results as reported in Thanikaimoni & Vasanthy (1972) using acetolysis staining method.

Table 1: Morphometrics of *Sarracenia* pollen grains (μ).

	F	Df1	Df2	Sig.
Equatorial	1.612	4	72	0.180
Polar	1.607	4	72	0.182
[a]Design: Intercept + Grp				

Table 2: Levene's test of equality of error variances[a]. This tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Post hoc estimates of power provide legitimate information in exploratory settings where an *a priori* estimate is not feasible. Power is strongly influenced by the level of significance, sample size and effect size. No universal rule for adequate power is available, but power of 80% or greater is sufficient for most research settings.

For analysis of equatorial values, with an average group size of 15.4, power of approximately 80% was determined. For the polar data, with an average group size of 26.6, power of 99% was determined, which is extremely strong. These post hoc estimates indicate that the power of the ANOVA tests to pick up true differences was sufficient for the equatorial data and immense for the polar data.

The separation of *S. flava* from the other species examined in this study is inconsistent with the results from other investigations. Interestingly, similarly to our own result, Bayer *et al.* (1996) had one species of *Sarracenia* (*S. alata*) as a sister group to a clade containing all the other species his group examined based on rbcL and ITS sequences. *Sarracenia flava* was found to be aligned with *S. alata*, *S. leucophylla*, *S. purpurea*, *S. psittacina*, and *S. rubra* by Freudenstein & Case (2002) based upon plastid DNA analysis, and in a later study utilizing nuclear DNA with just *S. oreophila* (Freudenstein *et al.* 2004). It was hoped these inconsistencies in species relationships could be addressed by utilizing pollen measurements, but we were unable to provide a precise means of distinguishing between all the species examined in this study by comparison of polar and equatorial dimensions. Unfortunately, the lack of resolution of relationships among *Sarracenia* species based upon pollen morphometrics excludes this technique as a way of elucidating their confounding taxonomy.

References

Bayer, R.J., Hufford, L., and Soltis, D.E. 1996. Phylogenetic relationships in Sarraceniaceae based on rbcL and ITS sequences. Systematic Botany. 21: 121-134.

Case, F.W. and Case, R.B. 1976. The *Sarracenia rubra* complex. Rhodora. 78: 270-325.

Chase, M.W., Soltis, D.E., Olmstead, R.G., Morgan, D., Les, D.H., Mishler, B.D., Duvall, M.R., Price, R.A., Hills, H.G., Qui, Y.-L., Kron, K.A., Rettig, J.H., Conti, E., Palmer, J.D., Manhart, J.R., Sytsma, K.J., Michaels, H.J., Kress, W.J., Karol, K.G., Clark, W.D., Hedren, M., Gaut, B.S., Jansen, R.K., Kim, K.-J., Wimpee, C.F., Smith, J.F., Furnier, G.R., Strauss, S.H., Xiang, Q.-Y., Plunkett, G.M., Soltis, P.S., Swensen, S.M., Williams, S.E., Gadek, P.A., Quinn, C.J., Eguiarte, L.E., Goldenberg, E., Learn Jr., G.H., Graham, S.W., Barrett, S.C.H., Dayanandan, S., and Albert, V.A. 1993. Phylogenetics of seed plants: An analysis of nucleotide sequences from the plastid gene rbcL. Annals of the Missouri Botanical Garden. 80: 528-580.

Conran, J.G. and Dowd, J.M. 1993. The phylogenetic relationships of *Byblis* and *Roridula* (Byblidaceae-Roridulaceae) inferred from partial 18S ribosomal RNA sequences. Plant Systematics and Evolution. 188: 73-86.

DeBuhr, L.E. 1975. Phylogenetic relationships of the Sarraceniaceae. Taxon. 24: 297-306.

Edlund, A.F., Swanson, R., and Preuss, D. 2004. Pollen and stigma structure and function: The role of diversity in pollination. The Plant Cell. 16: S84-S97.

Ellison, A.M. 2001. Interspecific and intraspecific variation in seed size and germination requirements of *Sarracenia* (Sarraceniaceae). Am. J. of Botany 88: 429-437.

Freudenstein, J.V. and Case, F.W. 2002. Relationships among pitcher plant species (*Sarracenia*) based on plastid DNA sequence analysis. Bot. Soc. of Am./American Society of Plant Taxonomy meetings (Botany 2002), Madison, WI, 4-7 August.

Freudenstein, J.V., Chaudhuri, A., and Case, F.W. 2004. Relationships among and delimitation of *Sarracenia* species: A nuclear DNA perspective. Bot. Soc. of Am. meeting (Botany 2004), Snowbird, UT, 1-4 August.

Godt, M.J.W. and Hamrick, J.L. 1996. Genetic structure of two endangered pitcher plants, *Sarracenia jonesii* and *Sarracenia oreophila* (Sarraceniaceae). Am. J. of Botany. 83: 1016-1023.

McDaniel, S. 1971. The genus *Sarracenia* (Sarraceniaceae). Bull. of the Tall Timbers Res. Station. 9: 1-36.

Nichols, M.L. 1908. The development of the pollen of *Sarracenia*. Bot. Gazette. 45: 31-37.

Schnell, D.E. and Krider, D.W. 1976. Cluster analysis of the genus *Sarracenia* L. in the south-eastern United States. Castanea. 62: 60-62.

Sheridan, P.M. 1991. What is the identity of the west gulf coast pitcher plant, *Sarracenia alata* Wood? Carniv. Pl. Newslett. 20: 102-110.

Thanikaimoni, G. and Vasanthy, G. 1972. Sarraceniaceae: Palynology and systematics. Pollen et spores. 14: 143-155.

Wang, Z-F., Hamrick, J.L., and Godt, M.J.W. 2004. High genetic diversity in *Sarracenia leucophylla* (Sarraceniaceae), a carnivorous wetland herb. J. of Heredity. 95: 234-243

Studying the rock-loving *Pinguicula lithophytica* of Cuba

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Keywords: Cultivation, *Pinguicula lithophytica*.

Introduction

This article is intended to provide additional information that is associated with the new species, *Pinguicula lithophytica* C. Panfet-Valdés & P. Temple but not included in the initial description (see page 90).

Pinguicula lithophytica was encountered during several visits to the Macizo Mountains of the Escambray in the Central Region of Cuba. During the first visit we found that the plants grew on vertical or near vertical calcareous rock walls, generally at the top, with numbers decreasing toward the ground. Few plants were found at lower levels of the rock face. However, further visits revealed that subsequent generations of the plant population moved, generally downward or sideways by up to 5 m. Further study revealed that the colonies were not growing where nearby trees, mainly coffee, had grown to create dense shade or where plants sharing the rock face grew bigger and out-competed the *Pinguicula* for light. Thus, it appears that *P. lithophytica* is a pioneer plant, colonising open areas of near vertical calcareous rock but unable to compete with other plant species that move in and take over.

The rock face where we first found *P. lithophytica* is part of a rock outcrop that is flat or almost flat on top, and there covered in very dense forest. The forest continuously sheds leaves that cover and therefore hides the substrate in which it grows. Carefully moving the decomposing leaf litter away revealed that the forest floor is composed of weathered and worn limestone, which from its sharp and irregular form can be seen to be at least in part the remains of coral. This calcareous rock easily allows rainfall to filter down through it and much of the water that does so then moves horizontally to seep out of the rock at the vertical or sloping sides. This seepage, either alone or possibly in association with rain that directly impacts the rock face, continuously wears away the wet and therefore soft rock wall. (When dried, samples of the rock set like concrete into a solid hard mass.) *Pinguicula lithophytica* grows on these wet deteriorating rock faces. By their nature, the rock faces are constantly wearing down so they cannot provide a permanent home. New plants constantly repopulate the ever-changing rock face.

Habitat threats and conservation

Even a single visit was enough to show that the area is heavily affected by people, and especially agricultural work; coffee plantings surround the area. Repeated visits revealed the extent of this impact, as coffee was clearly encroaching on the habitat both by being planted nearer to it and because the coffee was allowed to grow tall such that the habitat became increasingly more shaded and less suitable for *P. lithophytica*.

However, in general this area is not subject to massive disruption as a result of human interference such as farming or mining. This is in sharp contrast to other areas, including the Western lowlands of Pinar del Rio where farming and fires (accidental or otherwise) cause much carnivorous plant habitat damage and the Eastern highlands of Moa where mining causes significant impact.

Notwithstanding any actual or potential threats, *P. lithophytica* is found within a National Park where conservation is a primary and well practiced aim. (In fact all Cuban flora is protected under local conservation laws.)

Flower colour compared to *P. albida* and *P. jackii*

When the type specimen was encountered, the flower colour was recorded as white and photos taken at the time seem to support this. However, the first description of *Pinguicula jackii* Barnhart included mention of another species which Barnhart described as "probably merely the long-known *P. albida* of Wright, but with the white corollas sometimes showing a narrow margin of color". Seeds of *P. lithophytica* have been grown and the resultant mature plants were examined while flowering. The flowers of these cultivated plants clearly demonstrated the colouration that Barnhart described, petals being white in general but with a very fine touch of violet-blue colour along the edge of the petal lobes. Closer inspection revealed that each lobe is very lightly marked with fine violet-blue veins. As the original plants referred to by Barnhart do not appear to have associated herbarium sheets and as no further reference to the plants has been found, no other features are available to be compared. However, it seems improbable that this colouration of *P. lithophytica* can so match Barnhart's unidentified species and not be one and the same, especially as no other *Pinguicula* species appears to have colouration that is similar. The species Barnhart described as "probably merely the long-known *P. albida* of Wright" cannot be expected to have been *P. albida* as that species is of the lowlands, requiring constantly high (day and night) temperatures that are not encountered above 100 m. above sea level. Further, the flowers of *P. albida* have never been described as other than white, photographs of wild and cultivated plants show nothing other than white flowers and our own cultivation of *P. albida* never revealed any plants with violet-blue (or any type of blue) tipped petals.

The violet-blue veins of *P. lithophytica* may be so fine and faint as to be almost invisible without the aid of a camera, lens or microscope. As to the petal edges, these too are so finely tipped with violet-blue that one can almost believe the colour to be imagined, though a sideways glance or a maintained stare will reward the observer with a view of this truly unique *Pinguicula* colouration. As yet, we still do not know if wild plants are white because of exposure to more sunlight, for other causes deriving from the habitat or for other reasons, including that the colouration may be less noticed than if observing in a laboratory or other controlled situation. It is also worth noting that, by comparison, *Pinguicula jackii* has petals that are blue, not violet-blue, and the blue occurs on the entire petal surface, and not just at the lobe tips.

Ecological conditions

Pinguicula lithophytica is found at 725 metres above sea level. Although Cuba is within the tropics, at this elevation the nights are cool or even cold while the days are generally hot. In addi-

tion, the altitude results in nightly clouds that shroud the mountain. This contributes to the high humidity levels maintained by the water seeping from the rock. As is normal for *Pinguicula*, the plants are found in a north-westerly aspect, where direct sunlight is avoided. *Pinguicula lithophytica* habitat is exposed to a hot dry season and a cooler wet season. Excluding periods when hurricanes are affecting Cuba, the mountains can be significantly more breezy than the tropical lowlands. The variations in humidity and temperature encountered in the region where *P. lithophytica* is found are shown in Figure 1.

Although *P. lithophytica* lives within the same general area as *P. jackii*, we have never encountered the two species on the same rock face, though this is not evidence that they could not share the same habitat. Plants that did occur with *P. lithophytica* included *Chaptalia dentata* and *Begonia banaoensis*, bryophytes, and some fern species. On the top of the calcareous rock outcrops, we found mixed forest with epiphytes including orchids, ferns and *Peperomia* species. This forest floor was littered with old leaves and with some plants including terrestrial orchids.

Cultivation

Since its rediscovery, *P. lithophytica* has been cultivated and the entire life cycle observed through multiple generations. Meanwhile, *Pinguicula jackii* was first introduced into general cultivation by Harald Weiner in the 1980s. Regrettably, there is no record of anyone having succeeded in maintaining plants sourced from Weiner, presumably through ignorance of the plant's requirements. Fortunately, *P. jackii* is now back in cultivation and so comparison of the requirements of the two species can be made.

There are no significant differences between the basic requirements of *P. lithophytica* and *P. jackii*. Both have been grown to flower using a medium of calcareous rock. In the case of *P. lithophytica*, crushed tufa was used while for *P. jackii*, more readily available calcareous rock taken

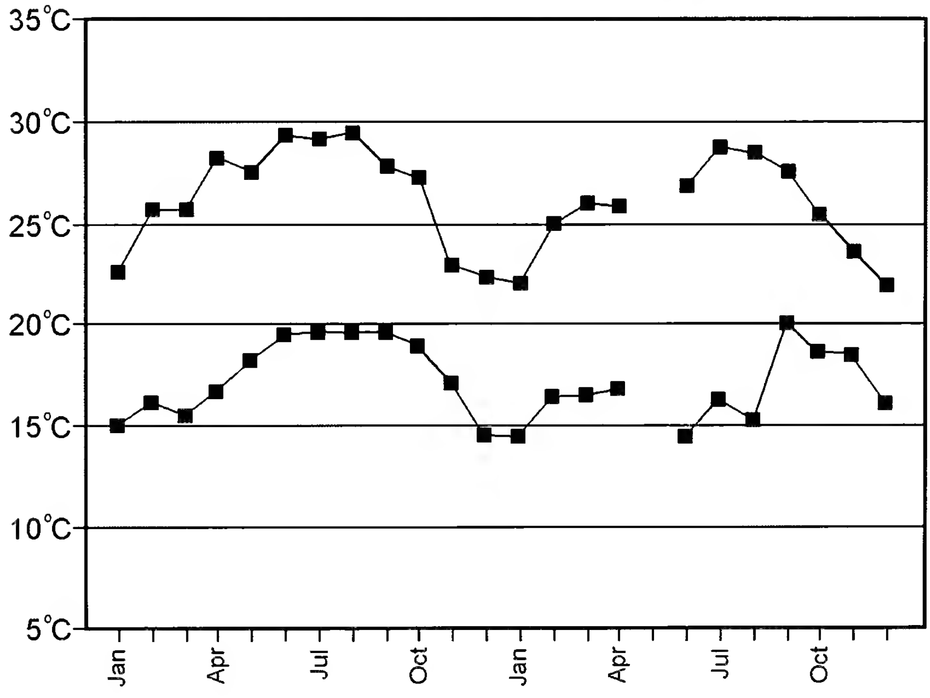

Figure 1: Temperature daytime maxima and nighttime minima as measured during a two-year period. No data were recorded for May of the second year.

from the habitat was used. Both plants required high humidity levels. Not much more is known about the water requirements of *P. jackii* as the plant has been maintained in fairly constant humidity in the calcareous growing medium that has been kept wet at all times. However, *P. lithophytica* has undergone additional experimentation and, provided the surrounding air is kept very humid, no water need be added to the calcareous growing medium for at least 6 months! Considering the nature of the constantly seeping habitat, such drought tolerance is a surprise. Should plants become generally available for cultivation, caution is advised with regard to attempts to replicate such dry conditions as a suitable growing method.

Both plants have been grown in strong light but protected from direct sunlight which will burn the leaves and ultimately kill such exposed plants. No experiments have been made with any form of plant food or fertiliser but it would be unusual for a *Pinguicula* to require, appreciate or even tolerate such treatment, especially in high or frequent doses.

Pinguicula lithophytica took 13 months to develop from fresh seed into flowering plants. Once flowering began, the same plants continued in flower for 6 or more months. Once flowering ceased, no plants that had flowered ever produced more flowers, even up to 3 years later. Seeds were first obtained by manually pollinating a single flower with pollen taken from that same flower. The resultant seed capsule was filled with copious seed all or nearly all of which were viable. *Pinguicula lithophytica* has been grown *in vitro*, though details of the medium or media used are not known.

Studying plants in Cuba

It goes without saying that Cuba is a plant-lover's dream. The country is packed with endemic species; it is just about impossible to visit the countryside without passing or even stepping on one or more botanical treasures. For *Pinguicula*-lovers, Cuba is a paradise, with numerous species, most of which are rare and all of which are endemic and attractive as well as interesting (to say the least). However, going to Cuba to see plants is not as easy as one might think, unless of course the intention is to see plants in Botanic Gardens. The Botanic Gardens are well designed and well stocked with a fantastic range of non-carnivorous plants. Efforts have been and are being made to grow carnivorous plants in the National Botanic Gardens in Havana but their availability is unreliable as Havana has a lowland climate that is a challenge to growers of the endemic *Pinguicula* species, many of which grow naturally in the highlands. (However, do not let that put you off a visit as the other plants are a delight, as are the Botanic Gardens' restaurants!)

If the intention is to see plants in the wild, this needs knowledge, assistance, planning and permission. To begin with, Cuba takes conservation very seriously. All countries are limited by their available budget and Cuba is no different. Cuban laws have strengthened their conservation efforts. It is now illegal for anyone to visit Cuba with the intention of entering the countryside to look for flora or fauna unless that person complies with the country's requirements. This means that a tourist visa simply will not do, a scientific visa is required even if you just intend to look, let alone study or take photographs. In order to obtain a scientific visa, the trip must be arranged by local people in Cuba and these people will need to be approved to make such arrangements. This is not optional. If they are not approved before you approach them, it is unlikely they will be given approval just because you want to visit. You will have to agree to take no plant or animal material out of Cuba, not even seeds. You will also be expected to agree that any knowledge gained as a result of your expedition will be published by your Cuban hosts, although it is possible to participate in joint publication as a co-author. You will also be wise to expect or offer to assist with the full costs of publication as such costs can be prohibitive for Cuban botanists and the organisations that employ them.

All National Park land in Cuba is supervised. This is done both by the local forest guards and by park supervisors, the latter sometimes being botanically aware or even expert. They do take an interest in all visitors, whether on foot, in vehicles, or on any other mode of transport! All

supervisors are free to approach any visitors to check the reason for their presence, to check if appropriate permission has been obtained (proof can be requested and required), and even to ensure that no specimens are being removed; searches are possible. The punishment for breaking the rules can be severe and immediate! One member of a party caught breaking a rule can cause the whole party to be held responsible.

However, field trips are welcomed. To undertake a field trip, letters will need to be sent to the relevant scientific institutions, for botanical trips these would normally need to be sent to the Ecology and Systematic Institute. The Cuban hosts, will thereafter assist with whatever guidance is needed. You will need to initiate contact at least six months in advance of the date of your intended trip, although this is really cutting it very fine, especially if you have had no previous contact with Cuban institutes; two years is a good realistic time to allow for planning unless you know exactly what you are doing and have prior experience in Cuba. Obviously, working with someone who knows what to do will help, but the Cuban authorities are used to organising visits for people new to Cuba and are both friendly and helpful.

Oh yes, one last thing. You will need funds. Getting around in the Cuban countryside, especially to see carnivorous plants, will require trips into areas where most available maps are useless. Weather or industry can destroy roads, and tracks may be muddy or impassable. They can even disappear seasonally! You will need a suitably robust vehicle and a good driver for you and your Cuban colleagues. As field trips are costly for Cuban organisations, it is not uncommon to find oneself accompanied by as many other local botanists as can fit in the transport. You will need to pay for everything, including all of the people, their wages (assessed to be what Cuba expects a European or American botanist to be paid), car rental, fuel, and all food and accommodation. Your coordinator (one will be assigned to you) will be able to tell you the probable cost in advance.

Permits

All of the various visits made to see and study Cuban *Pinguicula* have been done with appropriate permission from the relevant authorities. The expeditions did not require scientific visas as these have only become a requirement very recently. However, general permission to allow the first author to visit Cuba for the purpose of studying Cuban *Pinguicula* (and other carnivorous plants) was first obtained from the Cuban Consulate in London (United Kingdom). The Botanic Gardens in Havana then arranged all other permits needed to allow the expeditions to go ahead. In addition, staff from the Botanic Gardens (Jardin Botanico de Havana) accompanied all expeditions and, in some locations, local National Park supervisors participated in the field trip. No material was photographed or removed without permission. All Cuban laws and regulations were respected at all times.

Acknowledgements: Cristina M. Panfet-Valdés' contribution to this work was supported by Kew Latin America Research Fellowships KLARF (Programme), Andrew W. Mellon Latin America Botanical Fellowship (RBG Kew, UK), 2005. Paul Temple's contribution to this work was assisted by the National Botanical Garden of Cuba and in particular by the Director, Doctor Angela Leiva Sanchez and her staff, especially for their assistance in enabling the expeditions. The authors also wish to thank Christine Barker, Andrés Planas and Elivel Alonso Padron for their contributions to our knowledge.

Looking Back: CPN 25 years ago

Bruce Lee Bednar wrote: "A new monograph is needed for the genus *Nepenthes*. The *mirabilis* complex needs much work itself. Until a standard is achieved, many *Nepenthes* collectors will remain lost." Twenty-five years later we have seen many advances in our understanding of the genus, perhaps most visibly by Clarke's fine books. But in many ways, we are no closer to understanding *Nepenthes mirabilis*. I would love to see a more comprehensive review of these plants, and perhaps especially those of the Philippines and Thailand. (BR)

In vitro propagation of *Roridula gorgonias* (Roridulaceae)

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Keywords: conservation: *Roridula*—cultivation: tissue culture, *Roridula gorgonias*.

Two species of proto-carnivorous woody shrubs are represented in the genus *Roridula* (Roridulaceae Martinov, *nom. cons.*): *R. dentata* and *R. gorgonias* (Conran 2004). They are the only members of the Roridulaceae. These plants are endemic to the fynbos of the South African Cape Floristic Region, an area subject to periodic fires and marked by poor impoverished soils, warm, dry summers and comparatively cool, rainy winters (Cowling & Richardson 1995). Both species produce a sticky resin from glandular tentacles on their lanceolate leaves which entrap insects. Specialized hemipteran bugs feed upon the trapped insects and nutrients from bug feces are absorbed by the plants' leaves (Ellis & Midgley 1996) which show specialized anatomical features that may assist nutrient absorbtion (Anderson 2005). Analysis of $\delta\ ^{15}N$ levels in leaves (Midgley & Stock 1998) suggests that *Roridula* plants obtain much of their nitrogen requirements from insect prey and probably meet the criteria for true carnivory (Givnish 1989).

The interim 2007 South African IUCN Red Data list does not list *Roridula dentata* while *R. gorgonias* is listed as a least concern (LC) species. Even though *R. dentata* has had a historically wide distribution, frequent fires, wrong season fires, and habitat destruction by agriculture have eliminated populations previously documented by herbarium collections. It is possible that *R. dentata* may be given vulnerable (VU) or endangered (EN) status based upon current data (Royal Botanic Gardens 2007). The LC designation for *R. gorgonias* may change due to the same criteria as indicated for *R. dentata*.

Because seed of *R. dentata* may be produced in quantities too small for seed banking or to regenerate the soil seed bank *in situ*, this study of *R. gorgonias* was undertaken to determine *in vitro* propagation techniques that could be applied to *R. dentata* should the need arise for an alternative means to preserve germplasm. There is considerable horticultural interest in *Roridula* among botanical gardens and carnivorous plant hobbyists but because propagation by seed or cuttings is slow and difficult, plants are rarely if ever available in the horticultural trade (Opel 2005). *In vitro* methods could also be used to propagate plant material for horticultural and scientific use. Results presented in this paper describe the successful axenic propagation of *R. gorgonias* from seed.

Seeds were obtained from cultivated plants at the University of Connecticut Ecology and Evolutionary Biology Plant Growth Facility (voucher at CONN, #131684, M. R. Opel 261) and randomly divided into three groups: no scarification (n=13); scarification prior to surface sterilization (n=10); and scarification following surface sterilization (n=11). Scarification consisted of removal of a portion of the seed coat with a sterile scalpel blade.

Surface sterilization was achieved by 10 min exposure to a 10% (v/v) bleach solution. Seeds were then transferred in groups of 3-4 to 10 ml modified Murashige and Skoog (MS) media (Murashige & Skoog 1962) without rinsing. Basal MS medium consisted of micronutrients and iron used at full strength but macronutrients diluted to G strength (hereinafter referred to as G MS). Sucrose (20 g l^{-1}), MS vitamins (106 mg l^{-1}, Sigma-Aldrich Co., St. Louis, MO, USA), phytagel™ (6 g l^{-1}, Sigma-Aldrich Co., St. Louis, MO, USA) at pH 5.8 were added prior to autoclaving. Cultures were maintained at 25°C under cool-white fluorescent tubes with a 14:8-h photoperiod.

Figure 1: *Roridula gorgonias in vitro*. Photograph by Michael Bodri.

Figure 2: *Roridula gorgonias* root system *in vitro*. Photograph by Michael Bodri.

Seedlings were allowed to reach 5-6 cm length prior to subculturing onto G MS media containing 2 mg l-1 kinetin and 0.2 mg l-1 of the potassium salt of indole-3-butyric acid (K-IBA). Following stem proliferation and root production, plantlets were subcultured back to ? MS prior to greenhouse establishment.

Seeds, regardless of scarification regimen, began germinating within 23 d. Approximately 60% of all seed germinated (7/13 no scarification, 7/10 scarified prior to sterilization, 6/11 scarified after sterilization) with no significant difference between treatments (Fisher exact test, Fisher 1958). Root proliferation occurred prior to shoot proliferation, approximately one month post subculture, with adventitious roots developing from the stems of the seedlings above the culture media as well as within the media. Shoot proliferation occurred shortly thereafter from the base of the plants at the level of media rather than from the axillary buds not in contact with the media. After subculture in G MS supplemented with 2 mg l-1 kinetin and 0.2 mg l-1 K-IBA for 10-14 wks, the young shoots were grown enough to separate into individual plantlets. Separated plantlets developed normally when subcultured onto G MS without auxin and cytokinen (see Figures 1, 2). Plantlets readily established in the greenhouse after removal from culture media, the roots washed in tap-water and the plantlets transferred to plastic pots containing a non-sterile well-draining mixture of peat, sand and expanded clay material. Plants were covered with glass domes to increase humidity during a 4-wk acclimation period. We are still refining and improving this technique. For example, a current challenge is in long-term establishment of mature plants outside of the sterile conditions. For as yet unknown reasons, some plants that are potted and grown in greenhouse conditions (that support conventional, seed-grown *R. gorgonias*) may thrive for many months, then decline and die. This may be more of an issue related to their exacting cultivation requirements instead of their *in vitro* origins.

These results indicate that seed scarification and rinsing of seed with sterile water following surface sterilization is not necessary for successful germination of *R. gorgonias*. MS media used at G strength macronutrients and 20 g l-1 sucrose is a suitable media that supports axenic growth of this species and, if supplemented with kinetin and K-IBA, will initiate shoot and root proliferation.

The method described allows for the successful axenic production of *R. gorgonias*, and is likely applicable to *R. dentata*, as well.

References

Anderson, B. 2005. Adaptations to foliar absorption of faeces: a pathway in plant carnivory. Annals of Botany 95: 757-761.

Conran, J.G. 2004. Roridulaceae. In: Kubitzki K (ed) The families and genera of vascular plants. Vol VI. Flowering Plants. Dicotyledons. Springer, New York.

Cowling, R., and Richardson, D. 1995. Fynbos: South Africa's Unique Floral Kingdom. Fernwood Press, Vlaeberg, South Africa.

Ellis, A.G., and Midgley, J.J. 1996. A new plant-animal mutualism involving a plant with sticky leaves and a resident hemipteran. Oecologia 106: 478-481.

Fisher, R.A. 1958. Statistical methods for research workers. 13th ed. Hafner, New York.

Givnish, T.J. 1989. Ecology and evolution of carnivorous plants. In: Abrahamson WG (ed) Plant-animal interactions. McGraw-Hill, New York.

Midgley, J.J., and Stock, W.D. 1998. Natural abundance of ? ^{15}N confirms insectivorous habit of *Roridula gorgonias*, despite it having no proteolytic enzymes. Annals of Botany 82: 387-388.

Murashige, T., and Skoog, F. 1962. A revised medium for rapid growth and bioassays with tobacco cultures. Physiologia Plantarum 1: 474-497.

Opel, M.R. 2005. *Roridula*, a carnivorous shrub from South Africa. Carniv. Pl. Newslett. 34: 106-110.

Royal Botanic Gardens 2007 (citation date). Kew Millennium Seed Bank Project

Barry Rice (barry@sarracenia.com) writes: In the late spring of 2007 my wife and I were surveying a number of wetlands in the far northeastern region of California referred to as the Modoc Plateau. I was trying to track down new locations for *Utricularia*, especially *U. ochroleuca*. One shallow fen we visited on 26 May, filled with sedges and *Menyathes trifoliata*, was frustrating to me because I had only been able to find the vastly common *U. macrorhiza*. (I was even unsuccessful in finding *U. minor* at this fen, even though I knew that it had once occurred there.) Partly out of frustration I plucked one of the many *U. macrorhiza* flowers out of the muck and examined it. I stripped away the spur and lower corolla lobe to more easily gaze upon its sexual organs. The two apron-like lobes of the stigma were, as usual, spread widely. I poked them with a small probe, and was delighted to see that in a matter of seconds, the two stigmatic lobes flexed closed. I had known of this kind of behavior in some species of *Mimulus*, but had never heard of it before in the Lentibulariaceae. Clearly this is an adaptation by the plant to decrease the likelihood of self pollination by a pollinator backing out of the flower. Upon my return to my office, I reported this to Lubomir Adamec, who was able to immediately confirm that *Utricularia australis* has similarly sensitive stigmatic lobes. Jan Schlauer, meanwhile, informed me that this has indeed been reported before for aquatic *Utricularia*, as well as for a number of other plants in the Scrophulariales, but not *Genlisea* or *Pinguicula*. Even though this is not a new observation, I thought the readers of Carnivorous Plant Newsletter might like to see these images of the floral activity (below).

Ronald Buczek (phissionkorps@gmail.com) writes: The ability to switch the gender of *Nepenthes* plants would undoubtedly offer enormous benefits; from the accelerated creation of new hybrids and quickened selective breeding, to the possibility of ensuring the survival of a species that is known only from relatively few (or sometimes even one) micro-propagated clone. While much talk of how nice it would be to have these abilities abounds, I have been engaged in experiments to test if switching genders is at all feasible, based upon methods used by those researching the dioecious species *Cannabis sativa*. The reason these studies were chosen to model from, is that they offer in-depth information about gender switching in dioecious plants. Cytokinins are recommended to elicit a protandrous change in flower morphology, while auxins are recommended to elicit a protogynous change. I have treated approximately 20 *Nepenthes* seedlings of unknown (but presumably mostly male gender) with a solution of 15 mg l^{-1} 6-BAP. This method has switched the genders of male *Cannabis* plants to female or intersexual plants. Results for this experiment are still pending, and will not be known until the treated plants flower. I have also started experimenting with cytokinins on mature plants, but so far my treatments have killed the plants. I used the same concentration on them and apparently it was too high–I am still working on improving my methods. I expect that in the future I will write a paper describing my results.

Pinguicula lithophytica C. Panfet-Valdés & P. Temple (Lentibulariaceae Rich.), a new species from the central region of Cuba

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Keywords: New taxa: Cuba, *Pinguicula lithophytica*.

Received: 13 July 2007.

Abstract

This paper describes and illustrates a new species of *Pinguicula* L. from the central region of Cuba: *Pinguicula lithophytica* C. Panfet-Valdés & P. Temple. The new species is included in the section *Agnata*, subgenus *Isoloba*, with morphological relationship to *Pinguicula jackii* Barnhart. This is only the second species of *Pinguicula* to have been found in the Macizo mountains of the Escambray, in Cienfuegos Province, growing on calcareous rock at an altitude exceeding 600 metres above sea level.

Introduction

A previous reference to this species exists within the original description of *P. jackii* Barnhart (Barnhart, 1931). The author made reference to "two species" that were found in Santa Clara Province, Cuba, one of which was *P. jackii* and the other of which he described as "probably merely the long-known *P. albida* of Wright, but with the white corollas sometimes showing a narrow margin of color". There is no evidence that *P. albida*, typically a lowland species, does or can live at the relatively high (for the Caribbean) altitude at which *P. jackii* is found, *P. albida* requiring high day and night temperatures and high humidity at all times during the annual's short life.

Between 1995 and 1997 various expeditions were mounted into different regions of Cuba to study the carnivorous plants of that country (Temple & Panfet-Valdés 1998). Prior to the expeditions, the herbarium of the National Botanic Gardens in Havana was searched for evidence of herbarium vouchers referencing material of *Pinguicula*, as well as other carnivorous genera, but

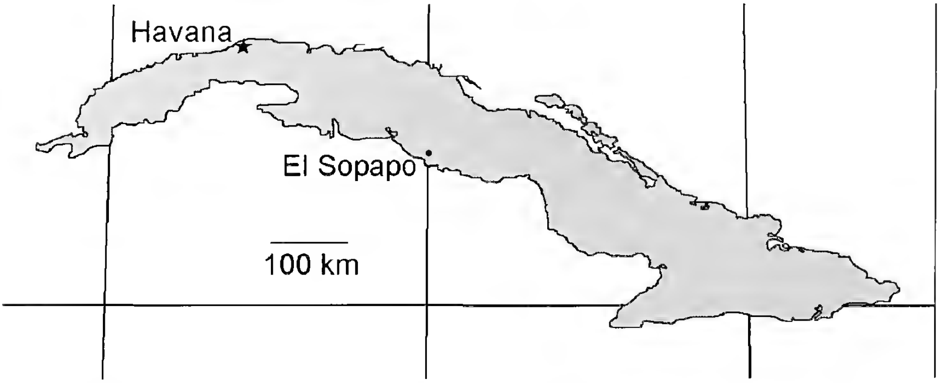

Figure 1: Map of Cuba, showing the El Sopapo collection site for *Pinguicula lithophytica*.

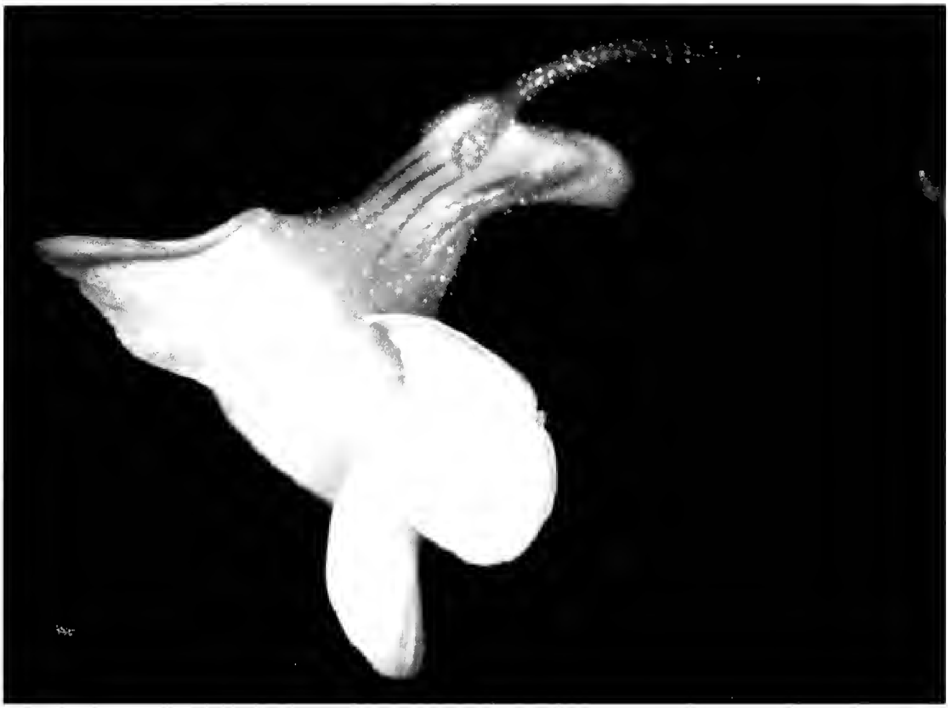

Figure 2: Profile view of *Pinguicula lithophytica* flower. Photograph by Paul Temple.

Figure 3: Front view of *Pinguicula lithophytica* flower. Photograph by Paul Temple.

few records were found, in particular very few for *P. jackii*. None of the few herbarium vouchers that were found for *P. jackii* were recent. Therefore, one motive for mounting the expeditions was to relocate *Pinguicula jackii*. While searching areas likely to support *P. jackii*, we were surprised to encounter a *Pinguicula* that did not correspond to the characteristics of *P. jackii* and which we considered to be a new species (see Figures 2, 3). This is probably the same species that Barnhart referred to but which he never described and for which herbarium vouchers are not known to exist.

This new species is remarkable for the presence of glandular hairs on the underside of the leaves (see Back Cover), a feature shared with few other *Pinguicula* species.

Pinguicula lithophytica C. Panfet-Valdés & P. Temple, *spec. nov.*

Herba annua vel biennis. Rhizoma simplex brevis radicibus adventitiis filiformibus. Folia 7-12, rosulam basalem 10-14 cm diametro in solo adpressam formantia, carnosa, 5-7 cm longa, 3-4 cm lata, pallida flavo-viridia, obovata, ad apicem obtusa vel rotundata, cuneata basi, pagina superiore pilis glanduliferis sessilis vel stipitatis dense tecta, pagina inferiore pilis glanduliferis stipitatis parce tecta, margine integerrimo, involuto. Scapi 1-3, erecti, 3-14 cm alti, pallidi flavo-virides, pilis glanduliferis stipitatis tecti, flore solitario. Flos 1-1.5 cm longus (calcari incluso), pallidus flavo-virens, bilabiatus. Calyx 0.2-0.4 cm longus, lobis oblongatis, ad apicem obtusis, pilis glanduliferis stipitatis tectis non nisi extus. Corolla 2 cm diametro, campanulata, alba sed inter bases loborum et calcaris lutea, lineis longitudinalibus brunneis ad calcarem evanidis, palato carens; labio inferiore profunde trilobo, lobi suborbiculari vel spathulato rotundato ad apicem, inferiore medio lobo majore quam duo aequalibus lobis lateralibus; lobi duo superiores quam lobi duo inferiores laterales grandiores, suborbiculares vel late obovati, faux tubusque corollae interior pilis cylindricis pluricellulis dense tecti pilis claviformis cylindricis basi conicis amplitudine numeroque versus calcar decrescentibus mixtis, calcar trichomatibus capitatis cellulus basalibus elongates. Calcar 0.5 cm longum, cylindricum, descendens, complanatum plus minusve dorso-ventraliter, bifidum plus minusve, ad apicem rotundum, pilis glanduliferis stipitatis ad apicem dispersis, pagina scapum adversa pilis carens, tubo corollae angulum obtusum (ad 110°-120°) faciens. Stamina curva, duobus filamentis complanatis. Ovarium ovoideum. Stigma bilabiata, inferiore labio quam superiore labio majore, crenata. Capsula ovoidea. Semina numerosa.

Perennial herb[1], rhizome short, with filiform adventitious roots; leaves 7-12, fleshy, 5-7 × 3-4 cm, pale green-yellowish, obovate, obtuse with rounded apex, base cuneate, upper surface densely covered with sessile and stalked glandular hairs, lower surface sparsely covered with stalked glandular hairs, margin entire, involute, forming a basal rosette of 10-14 cm diameter, lying flat on the ground. Scapes 1-3, erect, 3-14 cm tall, pale green-yellowish, covered with stalked hairy glands, one-flowered. Flower 1-1.5 cm long (spur included), pale green-yellowish, two lipped. Calyx 0.2-0.4cm long, lobes oblong, apex obtuse, covered with stalked glandular hairs only on the outer face. Corolla 2 cm diameter, bell-like, white, yellow between lobe bases and spur, with longitudinal brown lines fading toward the spur, without a palate; deeply trilobed inferior lip, suborbicular to spatulate, rounded at apex, lower central lobe larger than the two equal lateral lobes; bilobed upper lip, upper two lobes larger than the lower two lateral lobes, suborbicular to widely obovate, throat and internal half of corolla tube densely covered with cylindrical pluricellular hairs, mixed with claviform cylindrical hairs with conical base that diminish in size and decrease in numbers towards the spur. Spur 0.5 cm long, descendent, cylindrical, slightly dorso-ventrally flattened, slightly bifid, apex rounded, forming an obtuse angle (110-120°) with relation to the tube of the corolla, with dispersed stalked glandular hairs towards the apex, hairs absent on the face opposing the scape, with capitate trichomas the basal cells of which are elongated. Stamens, curved, with two flattened filaments. Ovary ovoid. Stigma bilabial, inferior lip greater than the superior one, crenate. Capsule ovoid. Seeds numerous.

Holotype: Cuba. Cienfuegos. San Blas, El Sopapo, Los Tornos. *C. Panfet, P. Temple, J. Gutiérrez. No. 71790.* (HAJB). 28 February 1995.

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[1]*Pinguicula lithophytica* is described as a short lived perennial. However, further studies will be necessary to determine if the plant is such or an annual/biennual.

	P. lithophytica	*P. jackii*
Leaf form	Obovate.	Cuneate-obovate.
Presence of leaf glands	Both surfaces glandular-hairy.	Only adaxial surface glandular-hairy.
Lower corolla lobes	Lobes non-overlapping.	Lobes all of equal size.
Corolla lobes colour	White.	Deep blue.
Spur form	Dorsiventrally flattened; cylindrical.	Slender, obtuse, or emarginate.

Table 1: A comparison of *P. lithophytica* and *P. jackii*.

Taxonomy: In accordance with Casper (1966), this species belongs in the section *Homophyllum*, of the subgenus *Pinguicula*. According to a phylogenetic restructuring by Cieslak *et al.* (2005), the new species would be assigned to section *Agnata*, subgenus *Isoloba*. *Pinguicula lithophytica* C. Panfet & P. Temple is closely related to but is not a variety of *P. jackii* Barnhart as demonstrated by the features that are compared in Table 1.

Distribution: Endemic. Central Cuba, located in the province of Cienfuegos, in the Macizo Mountains of the Escambray (see Figure 1).

Habitat: Generally growing on almost vertical slopes of calcareous rock that are the remains of elevated Karst formations, very degraded and eroded by seeping water, that had been semi-deciduous forest, with a northwest aspect, at an altitude of 725 metres above sea level.

Conservation concerns: The only known population of the plant occurs in an area that is surrounded by coffee cultivation and that has suffered much change as a result of human activity.

Etymology: This species has been given the name *Pinguicula lithophytica* because it grows on calcareous rock.

Acknowledgments: Cristina M. Panfet-Valdés' contribution to this work was supported by Kew Latin America Research Fellowships KLARF (Programme), Andrew W. Mellon Latin America Botanical Fellowship (RBG Kew, UK), 2005. Paul Temple's contribution to this work was assisted by the National Botanical Garden of Cuba and in particular by the Director, Doctor Angela Leiva Sanchez and her staff, especially for their assistance in enabling expeditions within Cuba. No plant material was removed and no wild locations were visited without all appropriate permissions, that were obtained by the National Botanical Garden of Cuba. All visits to wild locations were supervised by members of the National Botanical Garden of Cuba and, where necessary, by other officials. Both authors wish to also express their thanks to Barry Rice and to the referee of this paper for their assistance with its publication.

References

Barnhart, J.H. 1931. *Pinguicula jackii*. Addisonia 15, 4: 61-62. plate 511.

Casper, S.J. 1966. Monographie der Gattung *Pinguicula* L. Biblioth. Bot. 127/128: 1-209.

Cieslak, T., Polepalli, J.S., White, A., Müller, K., Borsch, T., Barthlott, W., Steiger, J., Marchant, A., and Legendre, L. 2005. Phylogenetic analysis of *Pinguicula* (Lentibulariaceae): chloroplast DNA sequences and morphology support several geographically distinct radiations. Am. J. of Bot. 92: 17223-1736.

Temple, P. and Panfet-Valdés, C. 1998. The *Pinguicula* of the Caribbean–Pp. 9-10 in: Schlauer, J. and Meyers-Rice, B. (eds.), Proc. Second Conf. ICPS, Bonn, Germany, 1998, ed. 2.–Bonn.

An Interview with Rick Walker

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Keywords: history: Rick Walker.

The ICPS Board wanted to honor Rick Walker for his long service to the ICPS and to the broader carnivorous plant community. What better way (OK, legally and within budget) than with an article about his experiences with carnivores? As the President of the ICPS, it was my pleasure to ask Rick about his involvement with the ICPS and his interest in carnivorous plants. Included is the requisite "I killed a Venus Flytrap with hamburger" story. It may be reassuring to see that someone as experienced and important to the ICPS as Rick has, or at least had, carnivorous feet of clay, just like the rest of us.

ICPS: How and when did you get involved in carnivorous plants?

Rick: My first grade teacher, Mrs. Ida Foster, grew a VFT every year in her class. I was so fascinated by her plant that she let me take it home at the end of the year. Of course at age 6 I pretty quickly killed it with bits of hamburger and flies. Good horticultural information was hard to find in 1965. However, the wonder of the VFT has stuck with all my life. When I finally graduated from school, got a job and little disposable time and cash, I decided to finally learn how to grow these plants and keep them alive and thriving.

ICPS: How did you get into the carnivorous plant listserv?

Rick: I started trading plants with a few friends by mail. I think Robert Allen told me about an informal email group in 1991. This led me to a half-dozen carnivorous plant enthusiasts that had been manually sending emails to each other for about a year. The original group consisted of Barry Rice, Don Burden, Michael Chamberland, Rob Maharajh, John Taylor, Robert Allen, Doug Atlas and Davin Stewart. By the time I got involved in late 1991, the group had grown to a few dozen people and it was starting to get tedious to manage the mailing list by hand. I offered to run a listserv program to make it easier for the group to expand. The list doubled in size every year from 1990 until 1998 until it reached its present stable size of about 1000 members, which interestingly, is about the same as the ICPS itself.

I believe that good communication is the foundation of peaceful and well-operating world. The CP listserv was my idealistic contribution towards fostering communication in the carnivorous plant microcosm. Of course, the CP listserv has had lots of good exchanges and heated debates and, yes, even a bit of name-calling. However, with very rare exceptions, all these conflicts have sorted themselves out without any need for moderation or censorship.

ICPS: How did the CP database come about?

Rick: In those days, it was hard to get good information or pictures of the new plants that were being traded. One of my first projects with the group was to put together a master growlist of all the people that were on the list. Looking for a definitive list of valid carnivorous plant names eventually led me to Jan Schlauer and his taxonomic list which at that time was only available as a xeroxed handout. In November 1994, Jan and I used his list to create the Carnivorous Plant Database now at http://www.omnisterra.com/bot/cp_home.cgi. The CP database hosts a good collection of donated pictures of carnivorous plants, monographs and other contributed items.

ICPS: What was it like to be the first ICPS president?

Rick: Being well-known for running the CP listserv probably contributed to my winning the first presidential election. It was really fun to work with Don Schnell, Joe Mazrimas and Leo Song who had published Carnivorous Plant Newsletter as a labor of love since 1972. My goal was to move the ICPS into a 501(c)(3) non-profit status and to increase its membership participation and scientific status. We expanded the editors, adding Jan Schlauer and Barry Rice, making CPN

a refereed journal. A big effort was made to improve our ability to accurately handle new memberships.

There were a few tough times where we actually worried about the ICPS going bankrupt. One year we got behind in Carnivorous Plant Newsletter publishing and only published 3 issues. California has a law saying that a club journal is only non-taxable if it is published 4 or more times in a year. Since we published just 3, we were liable for sales tax on all the journals for that year. Since Carnivorous Plant Newsletter had always been run hand-to-mouth, this caused us a huge amount of grief before we were finally able to settle back taxes.

My happiest time as President was attending the first ICPS International Conference in 1997 at Atlanta Botanical Gardens in Georgia. Meeting so many members from around the world was thrilling. The French carnivorous plants society gave me a little plaque of postage stamps depicting carnivorous plants from around the world signed by their members who attended the '97 conference.

ICPS: What other things would you like people to know about you or what would you like to say?

Rick: I've really enjoyed everyone I've ever met through the ICPS and my interest in carnivorous plants. It supports my idea that the world would be nicer place if we all did more gardening. Receiving a VFT as a first grader really impacted my life, and I hope my contributions have helped others to enjoy carnivorous plants too.

I encourage everyone to help reduce our footprint on the planet. Carnivorous plants, like most other non-human organisms, are in dramatic decline planet-wide. The only way forward that I can see is for us to reduce all of our energy and resource usage by at least 10:1. As an engineer, I'm putting a lot of thought into how to do this. Everyone needs to help wherever they can. We can all support appropriate legislation and efficiency improvements as they become available. Please continue to share the wonder of the natural world through carnivorous plants, and help everyone to see that nature is worth saving.

Literature Reviews

By John Brittnacher and Jan Schlauer

Kurata, S. 2008. *Nepenthes peltata* (Nepenthaceae), a new species of pitcher plant from the Philippines. Journal of the Insectivorous Plant Society (Japan) 59: 12-17 (2008).

The new species, originally found in the Mt. Hamiguitan Range, Mindanao, has peltate leaf apices, ovoid pitchers, and a basal crest and unusually large nectar glands on the interior lid surface. This combination of characters distinguishes *N. peltata* from similar species but makes precise placement in the genus difficult. The author considers it a member of the *N. villosa* group as defined by Jebb & Cheek (Flora Malesiana 15, 2001). (JS)

Walter, R.C., and Merritts, D.J. 2008. Natural Streams and the Legacy of Water-Powered Mills. Science 319: 299-304.

This article does not mention carnivorous plants or any particular plants. But it does present research about what the upland habitats of the Atlantic states of the USA were like before Europeans descended on North America. Today typical valleys in the Appalachians and adjacent uplands are characterized by deep, relatively dry, alluvial soils with meandering stream cuts to bedrock or gravel. In the 17th through 19th century, colonists from Europe built more than 65,000 dams to provide water power for mills. Walter and Merritts documented that alluvial soils in many of the valleys are less than 300 years old and result from silting of the millponds behind the dams. They found the ancestral conditions were wetlands with minimal soil but what soil was there was composed of relatively high levels of peat and mosses. The implications of this are that before European settlement and the damming of the streams, carnivorous plants could have been much more widespread in the USA Atlantic states. (JB)